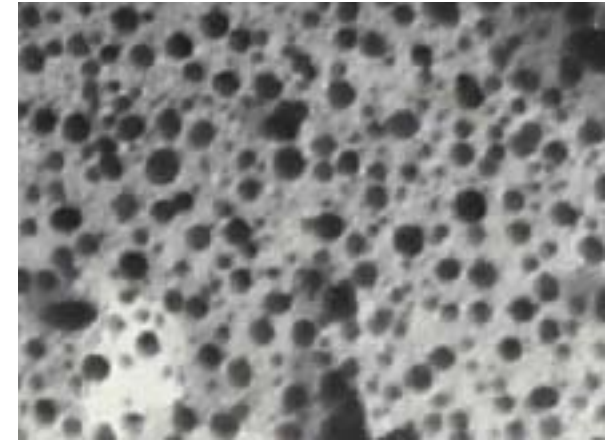


A colorimetric lead biosensor based on a gold-nanoparticle DNAzyme complex

David Hall, Karen Nordell, Alison Williams, Chorthip Peeraphadit, Melanie Ufkin

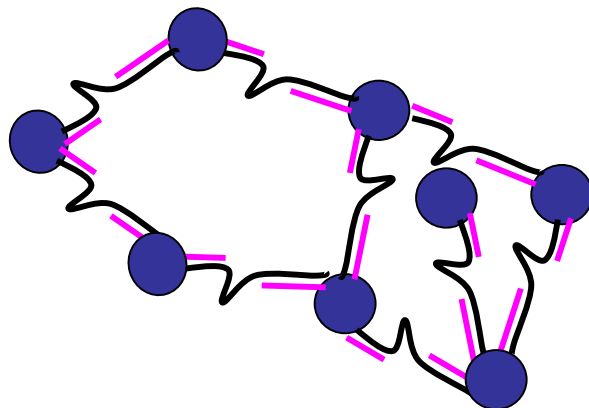
Lawrence University, Appleton, WI DUE-0304120

Lead is a neurotoxin that can irrevocably damage the brain and central nervous system. However, because of its widespread use in the past as gasoline and paint additives and its current use in many applications, some environments contain dangerously high levels of lead. Currently, atomic absorption spectroscopy is used to assay lead, and an alternative lead sensor that is sensitive, portable, and cost-effective would be a breakthrough in lead testing and monitoring. We are working with a colorimetric lead biosensor developed by Lu and Liu (J. Am. Chem. Soc. Vol. 125, 22, 2003). The biosensor complex is assembled by adding the DNAzyme to DNA functionalized gold nanoparticles designed with the specific sequence to hybridize to the DNAzyme. This sensor complex detects lead when the DNAzyme binds the lead and becomes activated thus freeing the gold nanoparticles held closely together in the complex by nucleic acids. This sensor technique provides a quantitative color change measured by UV-vis spectroscopy in the presence of different amounts of lead.

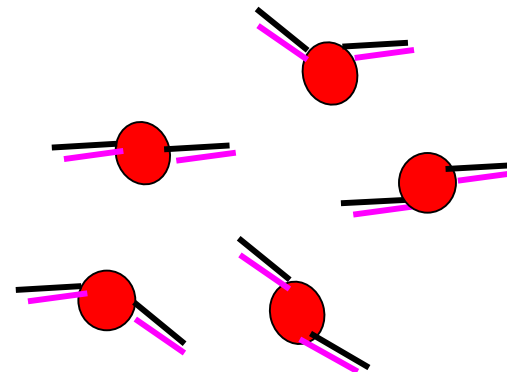


Transmission electron microscope image at magnification 60k showing the gold-nanoparticle DNAzyme sensor complexes with diameters of 100 – 200 nm.

Step 1: Assemble the biosensor complex of Au-nanoparticles (blue circles), and the DNAzyme (black and pink connections)



Add Pb^{+2}



Step 2: Add a sample containing Pb^{+2} and determine the color change using visible spectroscopy.

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Five undergraduate research students supported through the NUE grant have contributed to this project. The sensor preparation and lead detection has been adapted for use in undergraduate biology, biochemistry and chemistry lab courses to demonstrate nanoscience and nanotechnology applications. Small groups of first-year biology students carry out this experiment as a research project and present their results to their peers. We are adapting the experiment for use in analytical chemistry and instrumental analysis courses as a complementary experiment to lead detection using atomic absorbance spectroscopy. In addition, a group of six faculty from chemistry, biology and physics departments at various PUIs carried out the experiment as part of a PEW-sponsored workshop in March, 2003. This experiment is one of six nanoscience experiments we are adapting for use in the undergraduate biology, chemistry, biochemistry and physics laboratories at Lawrence University.



Biology students Shuan Hou and James Hustace record absorbance spectra for their lead sensor samples and generate the plot to the right that shows the color change of the sensor as a function of lead concentration.

